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Structural Design of Mechanically and Chemically Resistant Glasses

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Lithium aluminoborate glasses exhibit very high resistance to cracking under contact loading,[1,2] but low hardness and poor chemical durability in aqueous media. On the other hand, alkaline earth aluminoborate glasses feature improved chemical resistance and hardness, but lower resistance to cracking.[3] Here, we investigate the possibility to simultaneously improve the mechanical and chemical resistance of aluminoborate glasses by mixing alkali and alkaline earth modifiers. We study the mixed Li/Ba and Li/Mg aluminoborate glasses, since Li^+ and Ba^{2+} have different charge and size but similar modifier field strength (charge to size ratio), while Mg^{2+} has the highest field strength among these modifiers due to its small size. The two glass series thus give insights into the competitive effects of modifier charge and size on glass structure, mechanical properties, and dissolution rates in acidic, neutral, and basic solutions.[4] In order to access different structural roles of the modifier cations, we also study the effect of varying the aluminum-to-boron ratio in glasses with Li, Na, and Mg modifiers.[5] The structural origins of the trends in chemical and mechanical properties are discussed based on ^{11}B and ^{27}Al solid state NMR spectroscopy measurements.

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